Frequency and Antimicrobial Susceptibility Pattern of Methicillin Resistant *Staphylococcus Aureus* in Open Fractures

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ABSTRACT

Objective — *To determine the frequency and antibiotic sensitivity of methicillin resistant staphylococcus aureus (MRSA) in open fractures.*

Study design — *Descriptive case series.*

Place & Duration of study — *Orthopaedics & Traumatology Unit A Lady Reading Hospital Peshawar, from January 2014 to June 2016.*

Methodology — *Patients of both gender and all ages fulfilling the inclusion criteria were included in this study. Swabs were taken from wounds with Levine's technique and sent to the hospital laboratory immediately where standard methodology was adopted for culture and sensitivity of the pathogens in all cases and results were reported as per Clinical and Laboratory Standards Institute (CLSI) guidelines. All MRSA positive cases were isolated within 24 hours and the standard MRSA protocol implemented immediately.*

Results — *A total of 200 open fractures were sampled over a period of two and a half years. Positive cultures of MRSA were obtained in 47(23.5%) patients. The mean age of the patient was 24 year (range 18 year to 52 year). Males were 43(81.4%) while females 4(8.5%) in number. Open tibial fractures were highest (n=21, 44.6%) in number followed by femur (n=12, 25.5%). Majority (n=15, 31%) of the fractures were Type IIIA. All of the isolated MRSA cultures were 100% sensitive to vancomycin, linezolid, teicoplanin, chloramphenicol and tigecycline while resistance was observed for ciprofloxacin, levofloxacin, clarithromycin, and erythromycin.*

Conclusions — *Methicillin resistant staphylococcus aureus infection in open fracture wound is not uncommon. The isolated pathogen showed a variable pattern of sensitivity and resistance to the antibiotics tested.*

Key words — *Open fracture, Methicillin resistant staphylococcus aureus, Antimicrobial therapy.*

INTRODUCTION:

Open fracture or compound fracture is one in which there is overlying soft tissue wound in the skin communicating it to the outside environment.[1] High energy trauma due to motor vehicle accidents, gunshot injuries, fall from height and industrial or occupational injuries, is the usual cause of open fractures.[2,3] Open fractures constitute 3-4% of all the fractures.[4] It has been reported that approximately seventy percent of all open fractures are contaminated at the time of initial injury.[5] Gustilo-Anderson classification is most commonly used to categorize open fractures.[6] The usual bacterial pathogens isolated from open fractures are methicillin-sensitive *Staphylococcus aureus* (23% to 35%).[7,8] Other organisms are coagulase negative staphylococcus aureus (11%) and gram negative pathogens (31% to 48%).[7,9] Methicillin resistant

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Staphylococcus aureus in open fractures was first reported in 1986. These authors also observed that MRSA infections in open fractures caused an increase in re-surgery rates and morbidity, increased hospital stay, longer absence from employment or job, higher rate of amputations and greater financial burden.[10] As MRSA produces a biofilm on implants used in orthopaedics for fracture fixation, and the biofilm is much more resistant to antibiotics penetration, the rate of resistant to methicillin is much more higher in orthopedics than in other surgical or medical units and hence treatment of orthopedic infections not only becomes complicated but also costly.[11-13] Moreover bacteremia due to MRSA is twice lethal than that of methicillin sensitive *staphylococcus aureus* bacteremia.[14] This study aimed at finding out the frequency and sensitivity of MRSA infection in open fractures in our set up.

METHODOLOGY:

This case series study was conducted in Orthopaedics & Traumatology Unit "A" Medical Teaching Institution (MTI) Lady Reading Hospital Peshawar, from January 2014 to June 2016. Patients with open fractures of the limbs (Gustillo-Anderson types I, II and III) with clinical signs and symptoms of infection were included in the study. The study was approved by the Institutional Review Board. All the included subjects gave a written informed consent for the study. Complete history, general physical examination and local wound examination were carried out. X-ray of the involved limb was taken. Wound swabs from infected wounds were collected within 24 hours in orthopedic unit. All patients received a dose of first or second generation of cephalosporin on admission.

The technique of Levine was used for the collection of swab from open fracture wounds. [15] In this technique each wound was exposed and cleared of any exudate and contamination present on surface with a wet gauze or normal saline. A cotton tipped stick was then rotated over 1 cm area on the wound for five seconds with slight pressure so that any fluid and bacteria from inside of the wound squeezed outside and adhered to the cotton tip. Three samples were taken from every wound to avoid false negative results and enhanced the chances of culturing the offending bacteria. At least two of the three samples should have the same bacteria for results to be considered positive. All MRSA positive cases were isolated within 24 hours and the standard MRSA protocol implemented immediately.[16]

All the samples were immediately sent to the hospital laboratory where standard methodology was adopted for all the samples and blood agar, MacConkey's agar and Mannitol salt agar (MSA) were used for the inoculation of samples and overnight incubated at 37^{o}C. In case of positive growth, *Staphylococcus aureus* was identified through its unique cultural characteristics, biochemical properties and gram staining**.** Various antibiotics such as methicillin (MET) (5 mcg), Erythromycin (E) (15 mcg), Doxycycline (DO) (5 mcg), trimethoprim-sulphamethoxazole (SXT) (25 mcg), gentamicin (CN) (10 mcg), vancomycin (30 mcg), teicoplanin (30 mcg), linezolid (30 mcg), ciprofloxacin (5 mcg), chloramphenicol (30 mcg), clindamycin (2 mcg) and fusidic acid (10 mcg) were placed at 25 mm distance from each other and incubated at 37^{o}C for 16-18 hours. Zone of inhibition diameter around the discs were measured with a caliper in millimeters and results were reported according to the guidelines set by CLSI.[17] Collected data was analyses with SPSS (version 20). Frequencies and percentages were calculated. Data presented in tables where necessary.

RESULTS:

In this study a total of 200 infected open fractures wounds were swabbed in two hundred patients. Positive cultures of MRSA were obtained in 47 (23.5%) samples. Majority (n=38, 80%) of cultures yielded MRSA alone while MRSA along with other pathogens like *Coliform, Pseudomonas, Acineobacter and E Coli* (ESBL) were isolated in 4 (8.5%), 2 (4.2%), 2 (4.2%) and 1 (2.1%) cultures respectively. The mean age of the patient was 24 year (range 18 to 52 year). Male patients were 43 (81.4%) and female 4 (8.5%) in number. Majority (n=27, 57.4%) of the patients were under 40 year of age. The etiology of open fractures were motor vehicle accidents in 31 (65.9%) patients, gunshot injuries in 10 (21.2%) and fall from height in 6 (12.7%) patients. Most (n=35, 74.4%) of the patients were admitted within 24 hours of injury.

The frequency of distribution of open fractures with MRSA infection is shown in table I. Tibial fractures constituted the highest numbers of open fractures with MRSA positive (n=21, 44.6%) cultures. Initial debridement with or without fracture stabilization was done in 32 (68%) patients within 24 hours of sustaining fracture. The isolated MRSA susceptibility to antibiotics is shown in table II. All of the isolated MRSA cultures were 100% sensitive to vancomycin, linezolid, teicoplanin, chloramphenicol and tigecycline.

Table I: Frequency of Distribution of Open Fractures With MRSA Infection.

	Humerus		Radius Ulna		Femur		Tibia		Metatarsals	
Fracture Type	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**	**Right**	**Left**
Type I	-	-	-	-	2	1	2	3	-	-
Type II	1	-	-	-	1	2	2	1	1	-
Type IIIA	-	1	2	1	2	1	4	3	-	1
Type IIIB	-	-	1	-	1	1	2	1	3	2
Type IIIC	1	-	-	-	-	1	2	1	-	-

Table II: Antibiotics Sensitivity and Resistance Against MRSA

Antibiotics	Sensitivity n (%)	Resistance n (%)
Vancomycin	47 (100)	0 (0)
Linezolid	47 (100)	0 (0)
Teicoplanin	47 (100)	0 (0)
Chloramphenicol	47 (100)	0 (0)
Tigecycline	47 (100)	0 (0)
Gentamicin	24 (51)	23 (48.9)
Fusidic acid	22 (46.8)	25 (53.1)
Clindamycin	23 (48.9)	24 (51)
Trimethoprim-sulphamethoxazole	21 (44.6)	26 (55.3)
Doxycycline	25 (53.1)	22 (46.8)
Ciprofloxacin	0 (0)	47 (100)
Levofloxacin	0 (0)	47 (100)
Clarithromycin	0 (0)	47 (100)
Erythromycin	0 (0)	47 (100)

DISCUSSION:

In our study 23.5% of the open fractures yielded a positive culture of MRSA. The results of our study suggest that the frequency of MRSA infection in open fractures is still high and confirmed the findings reported by previous studies. The increased frequency of MRSA in our study could be due to the fact that most (65.9%) of the fractures were due to motor vehicle accidents with extensive wounds (type IIIA fractures) and contaminated. The other factor might be the debridement or stabilization of the open wounds which were delayed for more than 24 hours in some of the cases. In our hospital no separate operation theater was available for MRSA cases and no separate room or ward was allocated for open contaminated fracture wounds. Nurses and paramedics of our unit are also not properly trained in handling these infected cases.

In our study it was observed that all of the isolated MRSA cultures were sensitive to vancomycin, linezolid, teicoplanin, chloramphenicol and tigecycline while uniform resistance was observed for ciprofloxacin, levofloxacin, clarithromycin, and erythromycin. Drugs like gentamicin, fusidic acid and clindamycin, however showed mixed susceptibility pattern. A study of 112 patients of open fractures from Egypt reported that the frequency of MRSA was 4.7%, 8.3% and 100% in pre debridement swab, post debridement swab and swab three days after debridement respectively.[15] They also observed that the isolated MRSA was 100% sensitive to vancomycin, 60% sensitive to ciprofloxacin, and 40% sensitive to imipenem and cefoperazone both. In another study documented that MRSA isolated from open tibial fractures were most sensitive to vancomycin followed by chloramphenicol, teicoplanin

and ciprofloxacin.[16] One local study of 50 open fractures found that 90% of the fractures were infected with pathogens but MRSA was reported in only 2% of cases and was sensitive to only vancomycin and fucidin.[17]

CONCLUSIONS:

Methicillin resistant *staphylococcus aureus* (MRSA) infection in open fracture wound is not uncommon. The isolated pathogen showed a variable pattern of sensitivity and resistance to the antibiotics being tested.

REFERENCES:

1. Hauser CJ, Adams CA Jr, Eachempati SR. Council of the Surgical Infection Society. Surgical infection society guideline: Prophylactic antibiotic use in open fractures: An evidence-based guideline. Surg Infect (Larchmt). 2006;7:379-405.

2. Zalavras CG, Marcus RE, Levin LS, Patzakis MJ. Management of open fractures and subsequent complications. J Bone Joint Surg Am. 2007;89:884-95.

3. Ahmed E, Chaka T. Orthopedic and major limb trauma at the Tikur Anbessa University Hospital, Addis Ababa. Ethiopia Med J. 2006;44:175-81.

4. Anglen JO. Comparison of soap and antibiotic solutions for irrigation of lower-limb open fracture wounds. A prospective, randomized study. J Bone Joint Surg Am. 2005; 87:1415-22.

5. Cat T, Hall L. Trauma: Antibiotics in open fractures. Hosp Pharm. 2007;42:413-6.

6. Okike K, Bhattacharyya T. Trends in the management of open fractures. A critical analysis. J. Bone Joint Surg Am. 2006;88:27-39.

7. Carsenti-Etesse H, Doyon F, Desplaces N, Gagey O, Tancrede C, Pradier C, et al. Epidemiology of bacterial infection during management of open leg fractures. Eur J Clin Microbiol Infect Dis.1999;18:315-23.

8. Yokoyama K, Itoman M, Shindo M, Kai H. Contributing factors influencing type III open tibial fractures. J Trauma. 1995;38:788-93.

9. Johnson EN, Burns TC, Hayda RA, Hospenthal DR, Murray CK. Infectious complications of open type III tibial fractures among combat casualties. Clin Infect Dis. 2007;45:409-15.

10. Johnson KD, Johnston DW. Orthpedic experience with methicillin-resistant Staphylococcus aureus during a hospital epidemic. Clin Orthop Relat Res. 1986;212:281-8.

11. Turek SL. Orthopaedics principles and their application. 4th ed. New Delhi: Jaypee Brothers. 1984:258-82.

12. Thomas JG, Lehman DC, Biofilms: Architects of disease. In : Mahon CR, Lehman DC, Manuselis G, editors. Textbook of diagnostic microbiology, 3rd ed. New Delhi: Elsevier. 2007:884-98.

13. Roche SJ, Fitzgerald D, O'RourkeA, Mc Cabe JP. Methicillin-resistant Staphylococcus aureus in an Irish orthopaedic centre: A five year analysis. J Bone Joint Surg Br. 2006;88:807-11.

14. Whitby M, McLaws ML, Berry G. Risk of death from methicillin-resistant Staphylococcus aureus bacteraemia: A meta-analysis. Med J Aust. 2001;175:264-7.

15. Barakat G, Latief MA, Mostafa M, Morsy M. Can open fracture debridement improve post operative wound infection? Br J Med Med Res. 2016;16:1-11.

16. D Souza A, Rajagopalan N, Amaravati RS. The use of qualitative cultures for detecting infection in open tibial fractures. J Orthop Surg (Hong Kong). 2008;16:175-8.

17. Naeemullah, Shah H, Khan AH, Gul H, Baz KA. Common organisms and their sensitivity in open fractures of the extremities. Pak J Surg. 2012;28:186-92.

Author's Contributions:
Faaiz Ali Shah: Concept and design of the study, data collection and interpretation.
Shahab Ud Din: Final approval of the draft.
WaqarAlam: Manuscript writing.
Wali Mohammad Khan: Critical revision of the manuscript.

Conflict of Interest:
The authors declare that they have no conflict of interest.

Source of Funding:
None

How to cite this article:
Shah FA, Din S, Alam W, Khan WM. Frequency and antimicrobial susceptibility pattern of methicillin resistant *staphylococcus aureus* in open fractures. J Surg Pakistan. 2016;21(2):62-6. Doi:http://dx.doi.org/10.21699/jsp.21.2.6